

Don  
10/088569  
CA00/1097

PCT / CA 00 / 01097  
06 NOVEMBER 2000 (06.11.00)

PA 312575



# THE UNITED STATES OF AMERICA

~~TO ALL TO WHOM THESE PRESENTS SHALL COME:~~

UNITED STATES DEPARTMENT OF COMMERCE

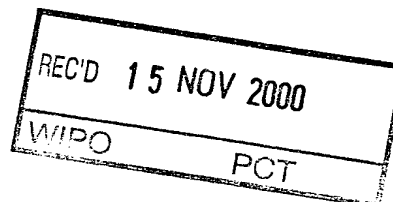
United States Patent and Trademark Office

October 06, 2000

THIS IS TO CERTIFY THAT ANNEXED HERETO IS A TRUE COPY FROM THE RECORDS OF THE UNITED STATES PATENT AND TRADEMARK OFFICE OF THOSE PAPERS OF THE BELOW IDENTIFIED PATENT APPLICATION THAT MET THE REQUIREMENTS TO BE GRANTED A FILING DATE UNDER 35 USC 111.

APPLICATION NUMBER: 09/401,780

FILING DATE: September 22, 1999



## PRIORITY DOCUMENT

SUBMITTED OR TRANSMITTED IN  
COMPLIANCE WITH RULE 17.1(a) OR (b)



By Authority of the  
COMMISSIONER OF PATENTS AND TRADEMARKS

*H. L. Jackson*  
H. L. JACKSON

Certifying Officer

Sep-22-99 12:08

From-SIM MCBURNEY

4165951163

T-506 P.03/30 F-152

**PATENT APPLICATION TRANSMITTAL LETTER**  
(Large Entry)Docket No  
1038-983 MIS:jbTO THE ASSISTANT COMMISSIONER FOR PATENTS

Transmitted herewith for filing under 35 U.S.C. 111 and 37 C.F.R. 1.53 is the patent application of:

Robert C. Brunham

For: DNA IMMUNIZATION AGAINST CHLAMYDIA INFECTION

Enclosed are:

- ☐ Certificate of Mailing with Express Mail Mailing Label No.
- ☒ Three (3) sheets of drawings.
- ☐ A certified copy of a \_\_\_\_\_ application.
- ☒ Declaration ☐ Signed. ☒ Unsigned
- ☐ Power of Attorney
- ☐ Information Disclosure Statement
- ☐ Preliminary Amendment
- ☐ Other.

**CLAIMS AS FILED**

For	#Filed	#Allowed	#Extra	Rate	Fee
Total Claims	23	- 20 =	3	x \$18.00	\$54.00
Indep. Claims	6	- 3 =	3	x \$78.00	\$234.00
Multiple Dependent Claims (check if applicable) <input type="checkbox"/>					\$0.00
BASIC FEE					\$760.00
TOTAL FILING FEE					\$1,048.00

- ☐ A check in the amount of \_\_\_\_\_ to cover the filing fee is enclosed
- ☒ The Commissioner is hereby authorized to charge and credit Deposit Account No. 19-2253 as described below. A duplicate copy of this sheet is enclosed.
- ☒ Charge the amount of \$1,048.00 as filing fee.
- ☒ Credit any overpayment.
- ☒ Charge any additional filing fees required under 37 C.F.R. 1.16 and 1.17.
- ☐ Charge the issue fee set in 37 C.F.R. 1.18 at the mailing of the Notice of Allowance, pursuant to 37 C.F.R. 1.311(b)

Dated: September 22, 1999

Robert C. Brunham 1924973  
Signature

cc:

TITLE OF INVENTIONDNA IMMUNIZATION AGAINST CHLAMYDIA INFECTIONFIELD OF INVENTION

5 The present invention relates to immunology and, in particular, to immunization of hosts using nucleic acid to provide protection against infection by Chlamydia.

BACKGROUND OF THE INVENTION

662260-0827060

DNA immunization is an approach for generating protective immunity against infectious diseases (ref. 1  
10 - throughout this application, various references are cited in parentheses to describe more fully the state of the art to which this invention pertains. Full bibliographic information for each citation is found at the end of the specification, immediately preceding the  
15 claims. The disclosure of these references are hereby incorporated by reference into the present disclosure). Unlike protein or peptide based subunit vaccines, DNA immunization provides protective immunity through expression of foreign proteins by host cells, thus  
20 allowing the presentation of antigen to the immune system in a manner more analogous to that which occurs during infection with viruses or intracellular pathogens (ref. 2). Although considerable interest has been generated by this technique, successful immunity has  
25 been most consistently induced by DNA immunization for viral diseases (ref. 3). Results have been more variable with non-viral pathogens which may reflect differences in the nature of the pathogens, in the immunizing antigens chosen, and in the routes of  
30 immunization (ref. 4). Further development of DNA vaccination will depend on elucidating the underlying immunological mechanisms and broadening its application to other infectious diseases for which existing strategies of vaccine development have failed.

35 Chlamydia trachomatis is an obligate intracellular bacterial pathogen which usually remains localized to mucosal epithelial surfaces of the human host.

Chlamydiae are dimorphic bacteria with an extracellular spore-like transmission cell termed the elementary body (EB) and an intracellular replicative cell termed the reticulate body (ref. 5). From a public health perspective, chlamydial infections are of great importance because they are significant causes of infertility, blindness and are a prevalent co-factor facilitating the transmission of human immunodeficiency virus type 1 (ref. 6). Protective immunity to C. trachomatis is effected through cytokines released by Th1-like CD 4 lymphocyte responses and by local antibody in mucosal secretions and is believed to be primarily directed to the major outer membrane protein (MOMP), which is quantitatively the dominant surface protein on the chlamydial bacterial cell and has a molecular mass of about 40 kDa (ref. 16).

Initial efforts in developing a chlamydial vaccine were based on parenteral immunization with the whole bacterial cell. Although this approach met with success in human trials, it was limited because protection was short-lived, partial and vaccination may exacerbate disease during subsequent infection episodes possibly due to pathological reactions to certain chlamydial antigens (ref. 8). More recent attempts at chlamydial vaccine design have been based on a subunit design using MOMP protein or peptides. These subunit vaccines have also generally failed, perhaps because the immunogens do not induce protective cellular and humoral immune responses recalled by native epitopes on the organism (ref. 9).

In copending US Patent Application No. 08/893,381 filed July 11, 1997, assigned to University of Manitoba and the disclosure of which is incorporated herein by reference (WO 98/02546), I have described the generation of a protective immune response using a DNA sequence

0040780 082260

Sep-22-99 12:10

From: SIM MCBURNEY

4165951163

T-506 P.07/30 F-152

3

which encodes the MOMP of *C. trachomatis* in a plasmid by DNA immunization.

#### SUMMARY OF THE INVENTION

The present invention is concerned with nucleic acid immunization, specifically DNA immunization, to generate in a host protective antibodies to a serine-threonine kinase of a strain of *Chlamydia*. DNA immunization induces a broad spectrum of immune responses including Th1-like CD4 responses and mucosal immunity.

Accordingly, in one aspect, the present invention provides a non-replicating vector comprising a nucleotide sequence encoding a serine-threonine kinase (STK) or a fragment of STK that generates a STK-specific immune response, and a promoter sequence operatively coupled to said nucleotide sequence for expression of said STK in a host to which the vector is administered.

The promoter may be a cytomegalovirus promoter, and may be contained in the human cytomegalovirus major immediate-early promoter-enhancer region. The vector may be a plasmid vector and the nucleotide sequence may be those of SEQ ID No: 1.

The strain of *Chlamydia* may be a strain of *Chlamydia* inducing chlamydial infection of the lung, including *Chlamydia trachomatis* or *Chlamydia pneumoniae*. The non-replicating vector may be plasmid pCDNA3 into which the nucleotide sequence is inserted. The pCDNA3 vector may contain the nucleotide sequence having SEQ ID No: 1.

In a further aspect of the present invention, there is provided an immunogenic composition for in vivo administration to a host for the generation in the host of a protective immune response to a serine-threonine kinase (STK) of a strain of *Chlamydia*, comprising a non-replicating vector as provided herein and a pharmaceutically-acceptable carrier therefor.

002260-0827060

In an additional aspect of the invention, there is provided as a method of immunizing a host against disease caused by infection with a strain of *Chlamydia*, which comprises administering to said host an effective  
5 amount of a non-replicating vector as provided herein.

In these aspects of the present invention, the various options and alternatives discussed above for the non-replicating vector may be employed.

The non-replicating vector may be administrated to  
10 the host, including a human host, in any convenient manner, such as intramuscularly or intranasally.

The present invention also includes, in a further aspect thereof, a method of using a gene encoding a serine-threonine kinase (STK) of a strain of *Chlamydia*  
15 or a fragment of said STK that generates a STK-specific immune response, to produce an immune response in a host, which comprises isolating said gene; operatively linking said gene to at least one control sequence to produce a non-replicating vector, said control sequence  
20 directing expression of said STK when introduced into a host to produce an immune response to said STK; and introducing said vector into a host.

In an additional aspect of the invention, there is provided a method of producing a vaccine for protection  
25 of a host against disease caused by infection with a strain of *Chlamydia*, which comprises isolating a nucleotide sequence encoding a serine-threonine kinase (STK) of a strain of *Chlamydia* or a fragment of the STK that generates a STK-specific immune response,  
30 operatively linking said nucleotide sequence to at least one control sequence to produce a non-replicating vector, the control sequence directing expression of said STK when introduced to a host to produce an immune response to said STK, and formulating said vector as a  
35 vaccine for in vivo administration to a host.

094401780-092299

The various options and alternatives discussed above may be employed in this aspect of the invention.

Advantages of the present invention, therefore, include a method of obtaining a protective immune response to infection carried by a strain of *Chlamydia* by DNA immunization of DNA encoding the major outer membrane protein of a strain of *Chlamydia*.

#### BRIEF DESCRIPTION OF DRAWINGS

Figure 1A and Figure 1B show the results of immunization with serine-threonine kinase gene (pSTK)-enhanced clearance of mouse pneumonitis (MoPn) infection in lung. Groups Balb/c mice were immunized with pSTK (n=5), pcDNA3 (n=6), saline (n=5) or with 1000 IFU of live MoPn EB (n=6). Fourteen days after last immunization, mice were challenged intranasally with infectious MoPn (2000 IFU). Figure 1A shows body weight of the mice was measured daily after challenge infection until mice were sacrificed at day 10. Figure 1B shows mice were sacrificed at postinfection day 10, and MoPn growth in lung was analyzed by quantitative tissue culture. Data are mean  $\pm$  SE of log<sub>10</sub> IFU/lung. \*p<0.05, p<0.01 vs. pcDNA-treated group. EB=host-killed elementary bodies, STK=plasmid DNA, Nonative, pcDNA3=empty vector.

Figure 2 shows the construction of plasmid pcDNA3/STK.

Figure 3 shows the nucleic acid sequence of the STK gene (SEQ ID No: 1).

#### GENERAL DESCRIPTION OF THE INVENTION

To illustrate the present invention, plasmid DNA was constructed containing the serine-threonine kinase (STK) gene from the *C. trachomatis* mouse pneumonitis strain (MoPn), which is a natural murine pathogen, permitting experimentation to be effected in mice. It is known that primary infection in the mouse model

00401780-092999

Sep-22-99 12:11

From-SIM MCBURNEY

4165851163

T-506 P. 10/30 F-152

6

induces strong protective immunity to reinfection. For human immunization, a human pathogen strain is used.

Any convenient plasmid vector may be used, such as pcDNA3, a eukaryotic II-selectable expression vector (Invitrogen, San Diego, CA, USA), containing a human cytomegalovirus major-immediate-early promoter-enhancer region. The STK gene may be inserted in the vector in any convenient manner. The gene may be amplified from *Chlamydia trachomatis* genomic DNA by PCR using suitable primers and the PCR product cloned into the vector. The STK gene-carrying plasmid may be transferred, such as by electroporation, into *E. coli* for replication therein. Plasmids may be extracted from the *E. coli* in any convenient manner.

15       The plasmid containing the STK gene may be administered in any convenient manner to the host, such as intramuscularly or intranasally, in conjunction with a pharmaceutically-acceptable carrier.

The data presented herein and described in detail below demonstrates that DNA immunization with the *C. trachomatis* STK gene elicits immune responses and produces significant protective immunity to lung challenge infection with *C. trachomatis* MoPn.

It is clearly apparent to one skilled in the art, 25 that the various embodiments of the present invention have many applications in the fields of vaccination, diagnosis and treatment of chlamydial infections. A further non-limiting discussion of such uses is further presented below.

## 30 1. Vaccine Preparation and Use

Immunogenic compositions, suitable to be used as vaccines, may be prepared from the STK genes and vectors as disclosed herein. The vaccine elicits an immune response in a subject which includes the production of anti-STK antibodies. Immunogenic compositions, including vaccines, containing the nucleic acid may be prepared as



Sep-22-99 12:11 From: SIM MCBURNEY

4165951163

T-506 P.11/30 F-152

7

injectables, in physiologically-acceptable liquid solutions or emulsions for polynucleotide administration. The nucleic acid may be associated with liposomes, such as lecithin liposomes or other liposomes known in the art, as a nucleic acid liposome (for example, as described in WO 9324640) or the nucleic acid may be associated with an adjuvant, as described in more detail below. ~~Liposomes comprising cationic lipids~~ interact spontaneously and rapidly with polyanions, such as DNA and RNA, resulting in liposome/nucleic acid complexes that capture up to 100% of the polynucleotide. In addition, the polycationic complexes fuse with cell membranes, resulting in an intracellular delivery of polynucleotide that bypasses the degradative enzymes of the lysosomal compartment. Published PCT application WO 94/27435 describes compositions for genetic immunization comprising cationic lipids and polynucleotides. Agents which assist in the cellular uptake of nucleic acid, such as calcium ions, viral proteins and other transfection facilitating agents, may advantageously be used.

Polynucleotide immunogenic preparations may also be formulated as microcapsules, including biodegradable time-release particles. Thus, U.S. Patent 5,151,264 describes a particulate carrier of a phospholipid/glycolipid/polysaccharide nature that has been termed Bio Vecteurs Supra Moléculaires (BVSM). The particulate carriers are intended to transport a variety of molecules having biological activity in one of the layers thereof.

U.S. Patent 5,075,109 describes encapsulation of the antigens trinitrophenylated keyhole limpet hemocyanin and staphylococcal enterotoxin B in 50:50 poly (DL-lactide-co-glycolide). Other polymers for encapsulation are suggested, such as poly(glycolide), poly(DL-lactide-co-glycolide), copolyoxalates,

0040780-02260

Sep-22-99 12:11

From: SIM MCBURNEY

4165951163

T-506 P.12/30 F-152

8

polycaprolactone, poly(lactide-co-caprolactone), poly(esteramides), polyorthoesters and poly(8-hydroxybutyric acid), and polyanhydrides.

Published PCT application WO 91/06282 describes a delivery vehicle comprising a plurality of bioadhesive microspheres and antigens. The microspheres being of starch, gelatin, dextran, collagen or albumin. This delivery vehicle is particularly intended for the uptake of vaccine across the nasal mucosa. The delivery vehicle may additionally contain an absorption enhancer.

The STK gene containing non-replicating vectors may be mixed with pharmaceutically acceptable excipients which are compatible therewith. Such excipients may include, water, saline, dextrose, glycerol, ethanol, and combinations thereof. The immunogenic compositions and vaccines may further contain auxiliary substances, such as wetting or emulsifying agents, pH buffering agents, or adjuvants to enhance the effectiveness thereof. Immunogenic compositions and vaccines may be administered parenterally, by injection subcutaneously, intravenously, intradermally or intramuscularly, possibly following pretreatment of the injection site with a local anesthetic. Alternatively, the immunogenic compositions formed according to the present invention, may be formulated and delivered in a manner to evoke an immune response at mucosal surfaces. Thus, the immunogenic composition may be administered to mucosal surfaces by, for example, the nasal or oral (intra-gastric) routes. Alternatively, other modes of administration including suppositories and oral formulations may be desirable. For suppositories, binders and carriers may include, for example, polyalkylene glycols or triglycerides. Oral formulations may include normally employed excipients, such as, for example, pharmaceutical grades of saccharine, cellulose and magnesium carbonate.

0910700-08270160

Sep-22-99 12:12 From-SIM MCBURNEY .

4165951163

T-506 P.13/30 F-152

9

The immunogenic preparations and vaccines are administered in a manner compatible with the dosage formulation, and in such amount as will be therapeutically effective, protective and immunogenic.

5 The quantity to be administered depends on the subject to be treated, including, for example, the capacity of the individual's immune system to synthesize the STK and ~~antibodies thereto, and if needed, to produce a cell-~~

mediated immune response. Precise amounts of active ingredient required to be administered depend on the judgement of the practitioner. However, suitable dosage ranges are readily determinable by one skilled in the art and may be of the order of about 1  $\mu$ g to about 1 mg of the STK gene-containing vectors. Suitable regimes for initial administration and booster doses are also variable, but may include an initial administration followed by subsequent administrations. The dosage may also depend on the route of administration and will vary according to the size of the host. A vaccine which protects against only one pathogen is a monovalent vaccine. Vaccines which contain antigenic material of several pathogens are combined vaccines and also belong to the present invention. Such combined vaccines contain, for example, material from various pathogens or from various strains of the same pathogen, or from combinations of various pathogens.

Immunogenicity can be significantly improved if the vectors are co-administered with adjuvants, commonly used as 0.05 to 0.1 percent solution in phosphate-buffered saline. Adjuvants enhance the immunogenicity of an antigen but are not necessarily immunogenic themselves. Adjuvants may act by retaining the antigen locally near the site of administration to produce a depot effect facilitating a slow, sustained release of antigen to cells of the immune system. Adjuvants can also attract cells of the immune system to an antigen

Sep-22-99 12:12

From: SIM MCBURNEY .

4165951163

T-506 P.14/30 F-152

10

depot and stimulate such cells to elicit immune responses.

Immunostimulatory agents or adjuvants have been used for many years to improve the host immune responses to, for example, vaccines. Thus, adjuvants have been identified that enhance the immune response to antigens. Some of these adjuvants are toxic, however, and can cause undesirable side-effects, making them unsuitable for use in humans and many animals. Indeed, only aluminum hydroxide and aluminum phosphate (collectively commonly referred to as alum) are routinely used as adjuvants in human and veterinary vaccines.

A wide range of extrinsic adjuvants and other immunomodulating material can provoke potent immune responses to antigens. These include saponins complexed to membrane protein antigens to produce immune stimulating complexes (ISCOMS), pluronic polymers with mineral oil, killed mycobacteria in mineral oil, Freund's complete adjuvant, bacterial products, such as muramyl dipeptide (MDP) and lipopolysaccharide (LPS), as well as monophoryl lipid A, QS 21 and polyphosphazene.

In particular embodiments of the present invention, the non-replicating vector comprising a first nucleotide sequence encoding a STK gene of Chlamydia may be delivered in conjunction with a targeting molecule to target the vector to selected cells including cells of the immune system.

The non-replicating vector may be delivered to the host by a variety of procedures, for example, Tang et al. (ref. 14) disclosed that introduction of gold microprojectiles coated with DNA encoding bovine growth hormone (BGH) into the skin of mice resulted in production of anti-BGH antibodies in the mice, while Furth et al. (ref. 15) showed that a jet injector could be used to transfect skin, muscle, fat and mammary tissues of living animals.

0040189-0821060

## 2. Immunoassays

The STK genes and vectors of the present invention are useful as immunogens for the generation of anti-STK antibodies for use in immunoassays, including enzyme-linked immunosorbent assays (ELISA), RIAs and other non-enzyme linked antibody binding assays or procedures known in the art. In ELISA assays, the non-replicating vector first is administered to a host to generate antibodies specific to the STK. These STK specific antibodies are immobilized onto a selected surface, for example, a surface capable of binding the antibodies, such as the wells of a polystyrene microtiter plate. After washing to remove incompletely adsorbed antibodies, a nonspecific protein, such as a solution of bovine serum albumin (BSA) that is known to be antigenically neutral with regard to the test sample, may be bound to the selected surface. This allows for blocking of nonspecific adsorption sites on the immobilizing surface and thus reduces the background caused by nonspecific bindings of antisera onto the surface.

The immobilizing surface is then contacted with a sample, such as clinical or biological materials, to be tested in a manner conducive to immune complex (antigen/antibody) formation. This procedure may include diluting the sample with diluents, such as solutions of BSA, bovine gamma globulin (BGG) and/or phosphate buffered saline (PBS)/Tween. The sample is then allowed to incubate for from about 2 to 4 hours, at temperatures such as of the order of about 20° to 37°C. Following incubation, the sample-contacted surface is washed to remove non-immunocomplexed material. The washing procedure may include washing with a solution, such as PBS/Tween or a borate buffer. Following formation of specific immunocomplexes between the test sample and the bound STK specific antibodies, and

0022260-092F0460

Sep-22-99 12:13

From: SIM MCBURNEY

4165951163

T-506 P.16/30 F-152

12

subsequent washing, the occurrence, and even amount, of immunocomplex formation may be determined.

#### EXAMPLES

The above disclosure generally describes the present invention. A more complete understanding can be obtained by reference to the following specific Examples. These Examples are described solely for purposes of illustration and are not intended to limit the scope of the invention. Changes in form and substitution of equivalents are contemplated as circumstances may suggest or render expedient. Although specific terms have been employed herein, such terms are intended in a descriptive sense and not for purposes of limitation.

#### 15 Example 1:

This Example shows the preparation of a plasmid vector for immunization.

The *C. trachomatis* mouse pneumonitis (MoPn) isolate was grown in HeLa 229 cells in Eagle MEM containing 10% fetal bovine serum and 2 mM L-glutamine. The MoPn EBs were harvested and purified by step gradient density centrifugation at 43,000g for 60 min at 4°C. The purified EBs were washed twice with PBS, centrifuged at 30,000g for 30 min, resuspended in sucrose-phosphate-glutamic acid (SPG) buffer and frozen at -70°C until used.

The serine-threonine kinase (STK) gene was cloned into eukaryotic expression plasmid, pcDNA3 (Invitrogen, San Diego) to form plasmid pcDNA3/STK. The STK gene was amplified from MoPn genomic DNA by polymerase chain reaction (PCR) with a 5' primer (GGG GAT CCG CCA CCA TGC TTG AAT TAG GCG TAT CGT TTC CT - SEQ ID No: 2) which included a *Bam*HI site, a start codon, and the N-terminal sequence of the mature serine-threonine kinase of MoPn and a 3' primer (GGG GCT CGA GCT ATT ACC GGA CTC TTT TTA AGC TGA TAA G - SEQ ID No: 3) which include a *Xho*I site,

002260 08210760

Sep-22-99 12:13

From-SIM MCBURNEY

4165951163

T-506 P.17/30 F-152

13

two stop codons (CTA TTA), and the C-terminal sequence of the MoPn STK gene. After digestion with *Bam*HI and *Xho*I, the PCR product, having the sequence shown in Figure 3 (SEQ ID No: 3), was cloned into *Bam*HI and *Xho*I restricted pCDNA3 with transcription under the control of human cytomegalovirus major intermediate-early promoter-enhancer region. The STK gene-encoding plasmid was transferred by electroporation into *Escherichia Coli* DH5 $\alpha$ , which was grown in luria-Bertani broth containing 100  $\mu$ g/ml ampicillin. The plasmid was extracted by a DNA purification system (Wizard Plus Maxiprep; promega, Madison, WI), and the sequence of recombinant STK DNA was verified by PCR direct sequence analysis. Purified plasmid DNA was dissolved in saline at a concentration of 1 mg/ml. The DNA concentration was determined by spectrophotometry (DU-62; Beckman, Fullerton, CA) at 260 nm, and the size of the plasmid was compared with DNA standards in a ethidium bromide-stained agarose gel.

Example 2:

This Example shows the results of immunizing studies using the plasmid vector.

Female Balb/c mice (4 to 5 weeks old) were purchased from Charles River Canada (St. Constant, Canada) mice were intramuscularly and intranasally immunized with plasmid DNA, prepared as described in Example 1, on three occasions, at 0, 2 and 4 weeks. For each immunization, a total of 200  $\mu$ g DNA in 200  $\mu$ l was injected into the two quadriceps muscles (100  $\mu$ g of DNA/injection site) using a 27-gauge needle. At the same season, 50  $\mu$ g DNA in 50  $\mu$ l was delivered onto the nostrils of mice with a micropipette. The droplet was subsequently inhaled by the mice.

Mice were challenged intranasally with 2x10<sup>3</sup> IFU of *C. trachomatis* MoPn EB 14 days after last immunization, as described. Briefly, after ether anesthesia 25  $\mu$ l of

00401780-002200

From-SIM MCBURNEY

4165951163

T-506 P. 18/30 F-152

5

10

15

## SUMMARY OF DISCLOSURE

25

30



Sep-22-99 12:14

From-SIM MCBURNEY

4165951163

T-506 P.19/30 F-152

15

REFERENCES

1. M.A. Liu, M.R. Hilleman, R. Kurth, Ann. N.Y. Acad. Sci. 772 (1995).
2. D.M. Pardoll and A.M. Beckerieg, Immunity 3, 165 (1995); W.M. McDonnell and F.K. Askari, N. Engl. J. Med. 334, 42 (1996).
3. J.B. Ulmer et al., Science 259, 1745 (1993); B. Wang et al., Proc. Natl. Acad. Sci. USA 90, 4156 (1993); G.J.M. Cox, T.J. Zamb, L.A. Babiuk, J. Virol. 67, 5664 (1993); E. Raz et al., Proc. Natl. Acad. Sci. USA, 91, 9519 (1994); Z.Q. Xiang et al., Virology 199, 132 (1994); J.J. Donnelly et al., J. Infect. Dis. 713, 314 (1996); D.L. Montgomery et al., DNA. Cell. Biol. 12, 777 (1993); J.J. Donnelly et al., Nature Medicine 1, 583 (1995); G.H. Rhodes et al., Dev. Biol. Stand. 82, 229 (1994); H.L. Davis, M.L. Michel, R.G. Whalen, Human Molecular Genetics 2, 1847 (1993); J.B. Ulmer et al., Vaccine 12, 1541 (1994); Z. Xiang and H.C.J. Ertl, Immunity 2, 129 (1995); E.F. Fynan et al., Proc. Natl. Acad. Sci. USA 90, 11478 (1993); E. Manickan, R.J.D. Rouse, Z. Yu, J. Immunol. 155, 259 (1995).
4. M. Sedegah, R. Hedstrom, P. Hobart, S.L. Hoffman, Proc. Natl. Acad. Sci. USA 91, 9866 (1994); M.A. Barry, W.C. Lai, S.A. Johnston, Nature 377, 632 (1995); D. Xu and F.Y. Liew, Vaccine 12, 1534 (1994); D.B. Lowrie, R.E. Tascon, M.J. Colston, Vaccine 12, 1537 (1994).
5. J.W. Moulder, Microbiol. Rev. 55, 143 (1991).
6. J. Schachter, Curr. Top. Microbiol. Immunol. 138, 109 (1988); S.D. Hillis and J.N. Wasserheit, N. Engl. J. Med. 334, 1399 (1996).
7. R.C. Brunham and R.W. Peeling, Infectious Agents and Disease 3, 218 (1994); R.P. Morrison, D.S. Manning, H.D. Caldwell, in Advances in Host Defence Mechanisms, T.C. Quin, Ed. (Raven Press, New York, 1992), pp 57-84.
8. J.T. Grayston and S.-P. Wang, Sex. Trans. Dis. 5, 73 (1978); J.T. Grayston and S.-P. Wang, J. Infect. Dis. 132, 87 (1975).
9. H.R. Taylor, J. Whittum-Hudson, J. Schachter, Invest. Ophthalmol. Vis. Sci. 29, 1847 (1988); B.E. Batteiger, R.G. Rank, P.M. Bavoil, J. Gen. Microbiol. 139, 2965 (1993); M. Campos et al., Invest. Ophthalmol. Vis. Sci. 36, 1477 (1995); H. Su, M. Parnell, H.D. Caldwell, Vaccine 13, 1023 (1995); T.-W. Tan, A.J. Herring, I.E. Anderson, Infect. Immun.

002260-0827060

- 58, 3101 (1990); M. Tuffrey, F. Alexander, W. Conlan, J. Gen. Microbiol. 138, 1707 (1992).
10. Y.-X. Zhang, J.G. Fox, Y. Ho, Mol. Biol. Evol. 10, 1327 (1993).
11. R.P. Morrison, K. Feilzer, D.B. Tumas, Infect. Immun. 63, 4661 (1995); H. Su and H.D. Caldwell, Infect. Immun. 63, 3302 (1995); J.U. Igiertseme et al., Reg. Immunol. 5, 317 (1993); J.U. Igiertseme and R.G. Rank, Infect. Immun. 59, 1346 (1991); D.M. Williams, J. Schachter, J.J. Coalson, J. Infect. Dis. 149, 630 (1984).
12. G. Tipples and G. McClarty, J. Biol. Chem. 270, 7908 (1995).
13. X. Yang, K.T. HayGlass, R.C. Brunham, J. Immunol., 156, 4338 (1996).
14. Tang et al., Nature 1992, 356: 152-154.
15. Furth et al., Vaccine 1994, 12: 1503-1509.
16. Morrison RP, Manning DS, Caldwell HD. Immunology of *Chlamydia trachomatis* infections: Immunoprotective and immunopathogenetic responses. In: Quin TC. Advances in host defence mechanisms. Sexually transmitted diseases. Vol. 8. New York: Raven Press, 1992: 52-84.

002200-08270400

CLAIMS

What I claim is:

1. A non-replicating vector comprising:

a nucleotide sequence encoding a serine-threonine kinase (STK) or a fragment of said STK that generates a STK-specific immune response, and

a promoter sequence operatively coupled to said nucleotide sequence for expression of said STK in a host to which the vector is administered.

2. The vector of claim 1 wherein said promoter sequence is a cytomegalovirus promoter.

3. The vector of claim 2 wherein the cytomegalovirus promoter is contained in the human cytomegalovirus major immediate-early promoter-enhancer region.

4. The vector of claim 1 which is a plasmid vector.

5. The vector of claim 1 wherein said nucleotide sequence has SEQ ID No: 1.

6. The vector of claim 1 wherein said strain of *Chlamydia* is a strain producing chlamydial infections of the lung.

7. The vector of claim 1 wherein said strain of *Chlamydia* is a strain of *Chlamydia trachomatis*.

8. The vector of claim 7 wherein said non-replicating vector comprises plasmid pcDNA3 containing said promoter sequence and into which said nucleotide sequence is inserted in operative relation to said promoter sequence.

9. The vector of claim 9 wherein said nucleotide sequence has SEQ ID No: 1.

10. An immunogenic composition for *in vivo* administration to a host for the generation in the host of a protective immune response to a serine-threonine kinase (STK) of a strain of *Chlamydia*, comprising a non-replicating vector as claimed in claim 1, and a pharmaceutically-acceptable carrier therefor.

002200-08270460

11. A method of immunizing a host against disease caused by infection with a strain of *Chlamydia*, which comprises administering to said host an effective amount of a non-replicating vector as claimed in claim 1.

12. A method of using a gene encoding a serine-threonine kinase (STK) of a strain of *Chlamydia* or a fragment of said STK that generates a STK-specific immune response, to produce an immune response in a host, which comprises:

isolating said gene,

operatively linking said gene to at least one control sequence to produce a non-replicating vector, said control sequence directing expression of said STK when introduced into a host to produce an immune response to said STK, and introducing said vector into a host.

13. The method of claim 12 wherein said control sequence is a cytomegalovirus promoter.

14. The method of claim 13 wherein the cytomegalovirus promoter is contained in the human cytomegalovirus major immediate-early promoter-enhancer region.

15. The method of claim 12 wherein said non-replicating vector is a plasmid vector.

16. The method of claim 12 wherein said nucleotide sequence has SEQ ID No: 1.

17. The method of claim 12 wherein said strain of *Chlamydia* is a strain producing chlamydial infections of the lung.

18. The method of claim 12 wherein said strain of *Chlamydia* is a strain of *Chlamydia trachomatis*.

19. The method of claim 12 wherein said non-replicating vector comprises plasmid pcDNA3 containing said control sequence into which said gene encoding STK is inserted in operative relation to said control sequence.

20. The method of claim 19 wherein said nucleotide sequence has SEQ ID No: 1.

002260-08210460

Sep-22-99 12:15

From: SIM MCBURNEY

4165951163

T-506 P.23/30 F-152

19

21. The method of claim 12 wherein said host is a human host.

22. A method of producing a vaccine for protection of a host against disease caused by infection with a strain of *Chlamydia*, which comprises:

isolating a nucleotide sequence encoding a serine-threonine kinase (STK) of a strain of *Chlamydia* or a fragment of said STK that generates a STK-specific immune response,

operatively linking said nucleotide sequence to at least one control sequence to produce a non-replicating vector, the control sequence directing expression of said STK when introduced to a host to produce an immune response to said STK, and

formulating said vector as a vaccine for in vivo administration to a host.

23. A vaccine produced by a method as claimed in claim 22.

0040780 092299

ABSTRACT OF THE DISCLOSURE

Nucleic acid, including DNA, immunization is used to generate a protective immune response in a host, including humans, to a serine-threonine kinase (STK) of a strain of *Chlamydia*. A non-replicating vector, including a plasmid vector, contains a nucleotide sequence encoding a STK or a fragment of the STK that generates antibodies that specifically react with STK and a promoter sequence operatively coupled to the first nucleotide sequence for expression of the STK in the host. The non-replicating vector may be formulated with a pharmaceutically-acceptable carrier for in vivo administration to the host.

0041780 002299

Sep-22-99 12:15 From-SIM MCBUT

4165951163

006 P.25/30 F-152

 Dock # No  
 1038-983 MIS:jb

## Declaration and Power of Attorney For Patent Application

### English Language Declaration

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name,

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

**DNA IMMUNIZATION AGAINST CHLAMYDIA INFECTION**

the specification of which

(check one)

☒ Is attached hereto.

☐ was filed on \_\_\_\_\_ as United States Application No. or PCT International Application Number \_\_\_\_\_ and was amended on \_\_\_\_\_ (if applicable)

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose to the United States Patent and Trademark Office all information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, Section 119(a)-(d) or Section 365(b) of any foreign application(s) for patent or inventor's certificate, or Section 365(a) of any PCT International application which designated at least one country other than the United States, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate or PCT International application having a filing date before that of the application on which priority is claimed.

Prior Foreign Application(s)

Priority Not Claimed

_____ (Number)	_____ (Country)	_____ (Day/Month/Year Filed)	<input type="checkbox"/>
_____ (Number)	_____ (Country)	_____ (Day/Month/Year Filed)	<input type="checkbox"/>
_____ (Number)	_____ (Country)	_____ (Day/Month/Year Filed)	<input type="checkbox"/>

09401780-092299

Sep-22-99 12:15

From-SIM MCBURNEY

4165951163

T-506 P.26/30 F-152

Page 2 of 3

I hereby claim the benefit under 35 U.S.C. Section 119(e) of any United States provisional application(s) listed below:

---

(Application Serial No.)

---

(Filing Date)

---

(Application Serial No.)

---

(Filing Date)

---

(Application Serial No.)

---

(Filing Date)

I hereby claim the benefit under 35 U. S. C. Section 120 of any United States application(s), or Section 365(c) of any PCT International application designating the United States, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application in the manner provided by the first paragraph of 35 U.S.C. Section 112, I acknowledge the duty to disclose to the United States Patent and Trademark Office all information known to me to be material to patentability as defined in Title 37, C. F. R., Section 1.56 which became available between the filing date of the prior application and the national or PCT International filing date of this application:

---

(Application Serial No.)

---

(Filing Date)

---

(Status)  
(patented, pending, abandoned)

---

(Application Serial No.)

---

(Filing Date)

---

(Status)  
(patented, pending, abandoned)

---

(Application Serial No.)

---

(Filing Date)

---

(Status)  
(patented, pending, abandoned)

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

09101780-092299



Sep-22-99 12:16

From: SIM MCBURNEY

4165951163

T-506

P.27/30

F-152

Page 3 of 3

**POWER OF ATTORNEY:** As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith. *(list name and registration number)*

Michael I. Stewart (24,973)

Send Correspondence to: **Sim & McBurney**  
6th Floor, 330 University Avenue  
Toronto, Ontario  
Canada, M5G 1R7.

Direct Telephone Calls to: *(name and telephone number)*  
(416) 595-1155

Full name of sole or first inventor <b>Robert C. Brunham</b>	
Sole or first inventor's signature	Date
Residence <b>Winnipeg, Manitoba, Canada.</b>	
Citizenship <b>Canadian</b>	
Post Office Address <b>c/o University of Manitoba Dept. of Medical Microbiology, Room 543, 730 William Avenue, Winnipeg,</b>	
<b>Manitoba, Canada.</b>	

Full name of second inventor, if any	
Second inventor's signature	Date
Residence	
Citizenship	
Post Office Address	

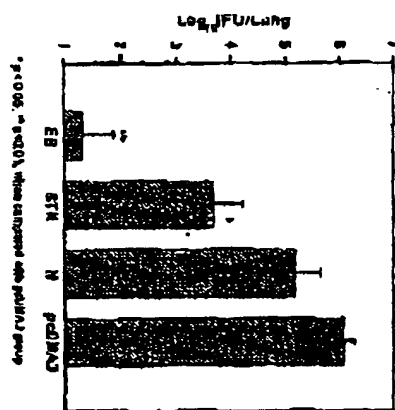


Fig 10

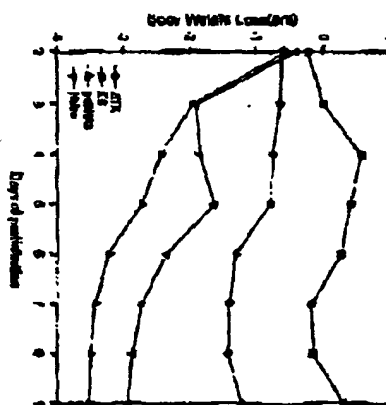
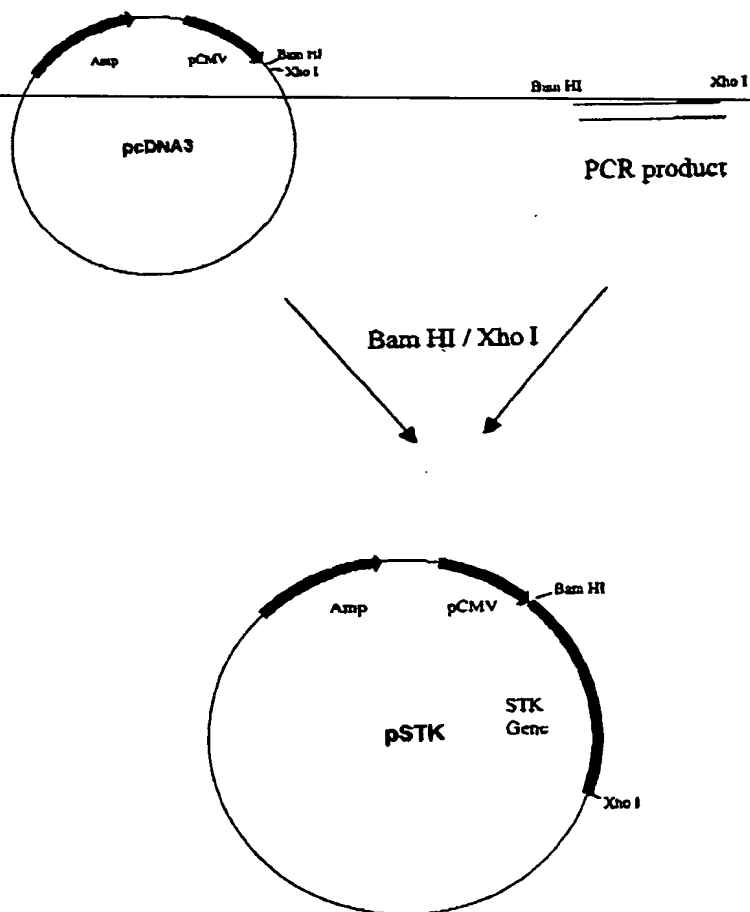


Fig 11

09404780.082299

Figure 2 Construction of pSTK



00401780-092299

Sep-22-99 12:16

From: SIM MCBURNEY

4165951163

T-506 P.30/30 F-152

length: 1467 nucleotides

end5: 829441

Serine - Threonine Kinase

end3: 827975

MW:

pI:

&gt;ORF00963

ATGCTTCGAATTAGGCGTATCGTTTCCTCCAGACTAAATATCTTCTUACACGAGAACTT  
AGTCGTAAGGTAGGCTTGACTGTCTATCAAGGAGTGGATGAGAGTTCTCTCGTCTCTG  
GTGATCAAGCATTGGTATCTCCAGGCAATTCATGACCAGCGTTTTCTTCGTCTTTTGA  
GAAGAAGCTAGGATTATGCAACTTGTAGATCATCCGGCATTGTTCGATTAGAAAGAAAA  
GGTGAGTGGGAGCAAGGACGTTATTTCTGTTTCTGAATATATTTTAGGSCATTTCATTCGA  
CATATTATCTTTTCATCTCATCTCGCTTTGGATAAGGCACTTCTATTTCTTTACAACTA  
CCGCAGGCAATAACGGCTCTTCATAAACATCATGTTTACATCTCGATATTAAACCTGAA  
AACATCATGATTCTCCGTTGGGAGAGGTCAGTTGATCGATTATGGGCTTTCAGCCTGG  
CAATTTAATCATTGGGCTTCGCTGCATATATGAGTCCCGAACAGAGCAGGCAGGAAAAAG  
CTATCTCCCGCATCCGATGTGTATGCTTTAGCTTTGTTAGCTTATGAGCTGATTATGGGG  
CAGCTTTCTTTAGGAAAGGTCTATTTATCTTTACTCCCCGTAAAGATTACTAAAGTCTTA  
ACTCAAGCATTGCAACCAGACCCAGAACACGGTTTCTTCTATGCTAGAGTTTGCTACC  
GCTTTGCAAGATTATCTTATGCTATGATGTGCAAGGATTATCTGTAJAAAGATCGCGTA  
ATCATGCACTTTGAAAGCTTGCAGCAACAAATATGTGGCTGGCTCCAGATAAGCTTTGC  
ATGCCGGAAGGGATGGCTCTGCACATTATTTCAAAAAGAGCCCTTTGATTACATAAT  
GTTTACTATGATATACTTAGGCTCTGAGGATATAGTAGAATTGTGGTTCTGTTATGCTCA  
GGCCTACTGTAGTTTTCCTCTTAGTATGATCAAAAGCTTTCTTAATCAGCGAACAGACAAA  
GGCAAGATATCCCAACAGTAATAAAACATTGGATACTCTTTGTAAACAATGCATATT  
CCGCTTTGTGAAAAAGGATTTCCTCTGCTGCTTTTATATTTTTCACACAGAACTCATG  
TGCTTTTCTTGTGGGAAAGCTGATTTCCTCGTTAAAAAAGCAAAACGAGCGAGTGCAACGT  
TTTCAAGCGGAATCGCAAGGAATAGGGGAAGAGGGACCCCTGGAGATCCACAACAAATCT  
TTTTTCTGGGAACCTGGTCATGAGCTTATCGTACACACCCCGAGGGCTAGAGATTGCTA  
TATTTATACTGTCTTCTTCTCTGAAGTTGCAAGATAGAGGGCAATGGATATATCTGC  
CAACAGATTACCTTCAGAAAGGAGTGAGGCAGAGTATGACGGAAJTCCTTTATCTTCA  
ACACTTATCAGCTTAAAAAGAGTCCGG

fm 3